A NEW SCENARIO FOR THE FORMATION OF STRIATIONS IN THE DUST TAIL OF COMET HALE-BOPP (C/1995 O1)

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We introduce a six-parameter formalism of the particle-fragmentation model for striated tails of comets. In addition to the usual parameters of the formerly employed three-parameter formalism, we can solve for three Cartesian components of the parent's velocity of release from the comet. Among the choices available, we opt for a scenario in which massive, parent objects are, before disintegration, subjected to no repulsive acceleration. The fragmentation products, which make up striae, are clouds of microscopic grains affected by a wide range of solar radiation pressure.
This scenario can explain the system of striations, detected in the dust tail of comet Hale-Bopp on wide-field photographs taken with Schmidt cameras on March 2–20, 1997. The only acceptable solutions are those showing that the parents were released near the comet's aphelion with velocities of a few m/s. Since major nucleus activity is not realistically possible that far from the Sun, release of massive bodies is either a spontaneous, outgassing independent process or their escape from the comet's gravitational field. In the latter case, the parents had broken off at earlier times and became the comet's temporary satellites in unstable orbits, from which they eventually strayed.
Although the time of parent release is to some extent constrained by limits set on the parent-release velocity and fragment accelerations, it is not well determined. To satisfy the convergence conditions of the differential-correction method used, it was necessary to adopt a particular time of release as a first approximation. After some experimentation, we chose aphelion.
The release-velocity vectors for all striae are distributed, with high accuracy, along a great circle. For rotationally driven velocities, this obviously is an effect of the comet's conserved angular momentum. The great circle's poles define the position of the rotation axis at true separation times, with the north pole at R.A. = 290°, Decl. = -66°, in good agreement with other determinations.
We conclude that large numbers of boulder-sized bodies, released from the nucleus at low velocities, may have circled it for extended periods of time before escaping the comet's gravitational pull.